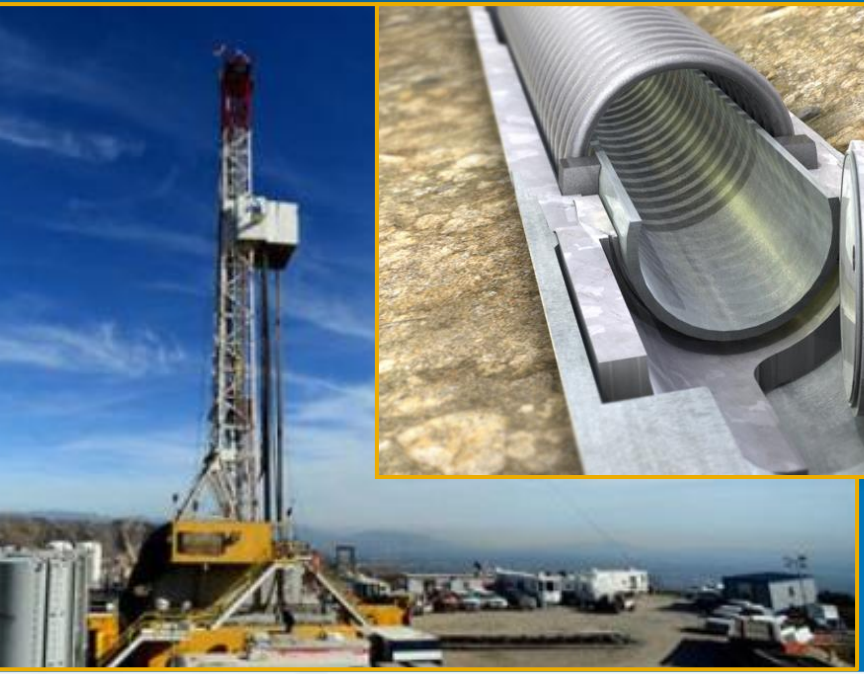
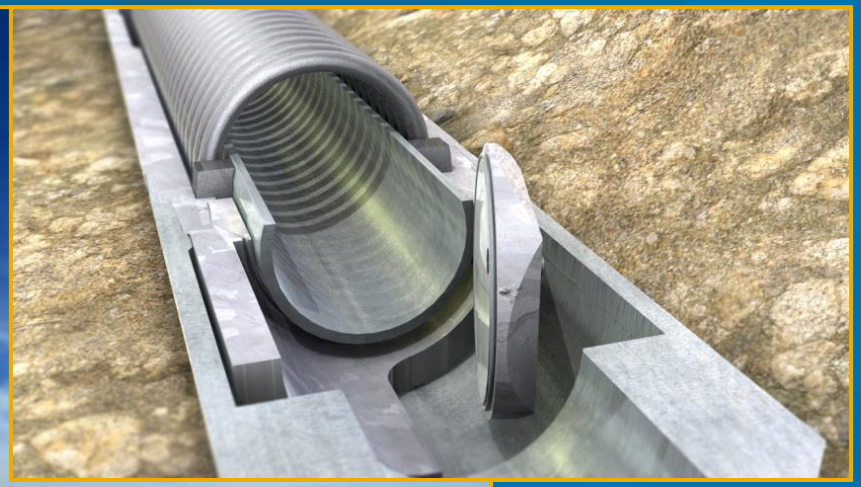
Subsurface Safety Systems





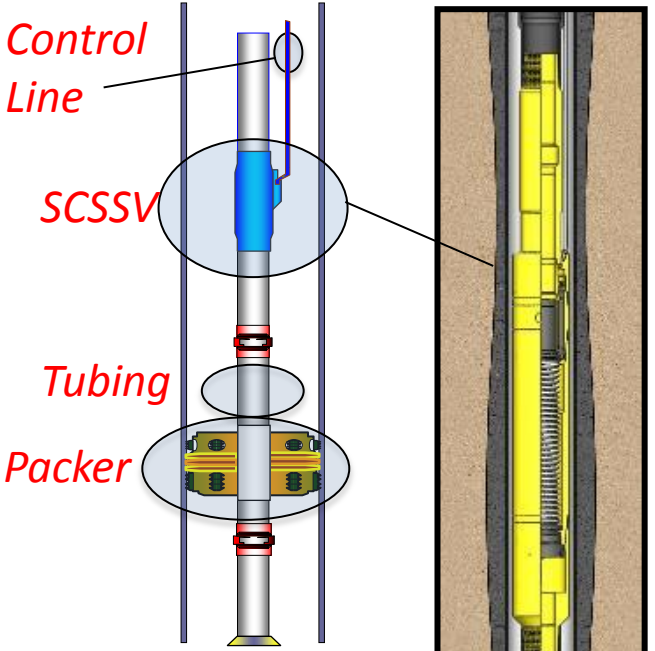
July 2016 – Denver, Colorado

Downhole Safety Systems – Broken Arrow, Oklahoma
Marc Garrett, Applications Engineering 918-259-2013
marcus.garrett@bakerhughes.com

Subsurface Safety Valve Definition

Subsurface Safety Valves are emergency fail-safe flow controlling devices which are installed below the Tubing Hanger that open and close to provide well control in cases of lost wellhead and near-wellhead integrity.

All Subsurface Safety Valves require a change in well conditions to activate its closure mechanism.



Typical
Gas Well
Configuration

Why do we need Safety Valves in Gas Storage Wells?

Protection:

- Populated Areas
- Capital Investment
- Environment

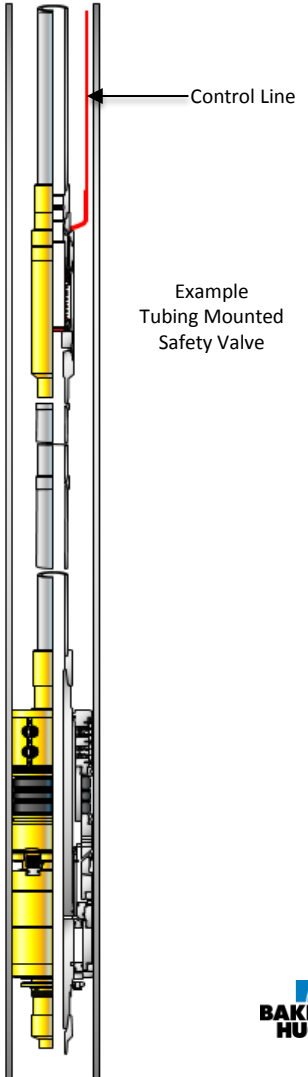
Applications near populated areas include installations near:

- Airports / Highways / Railways
- Homes / Schools

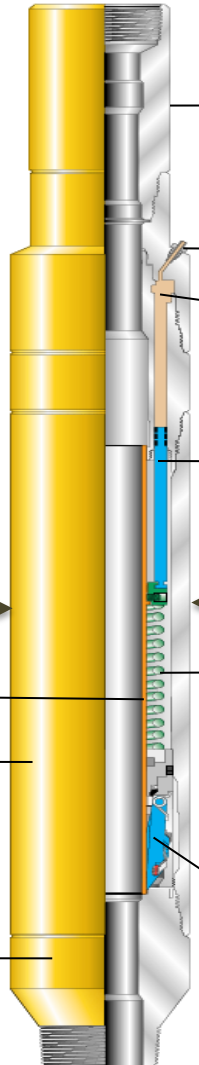
BAKER HUGHES

Surface Controlled Subsurface Safety Valves (SCSSVs):

- Hydraulically controlled via a ¼" OD control line leading from surface to SV
- Normally closed devices
  - Activates into open position with Hydraulic Pressure via Control Line
  - If there is a loss of control line pressure, the valve will return to the closed position (Fail-Safe Closed)
- Fail Safe
  - A catastrophic wellhead failure will cause the valve to close.
- Pump Through Kill Feature (**Flapper Type**)
  - Whether the valve is working or not working, the valve has the ability to be pumped through so the well can be killed.
- **3 Types of Downhole Surface Controlled Safety Valves:**
  - **Tubing Conveyed (Most Prevalent and Reliable)**
  - **Wireline (Slickline) Conveyed**
  - **Annular Safety Valves**



Tubing Conveyed Safety Valves
Major Components

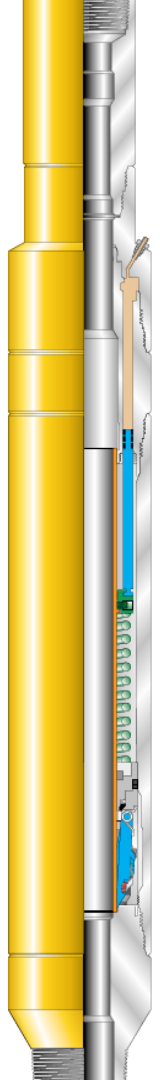


BAKER HUGHES

Tubing Conveyed Subsurface Safety Valves

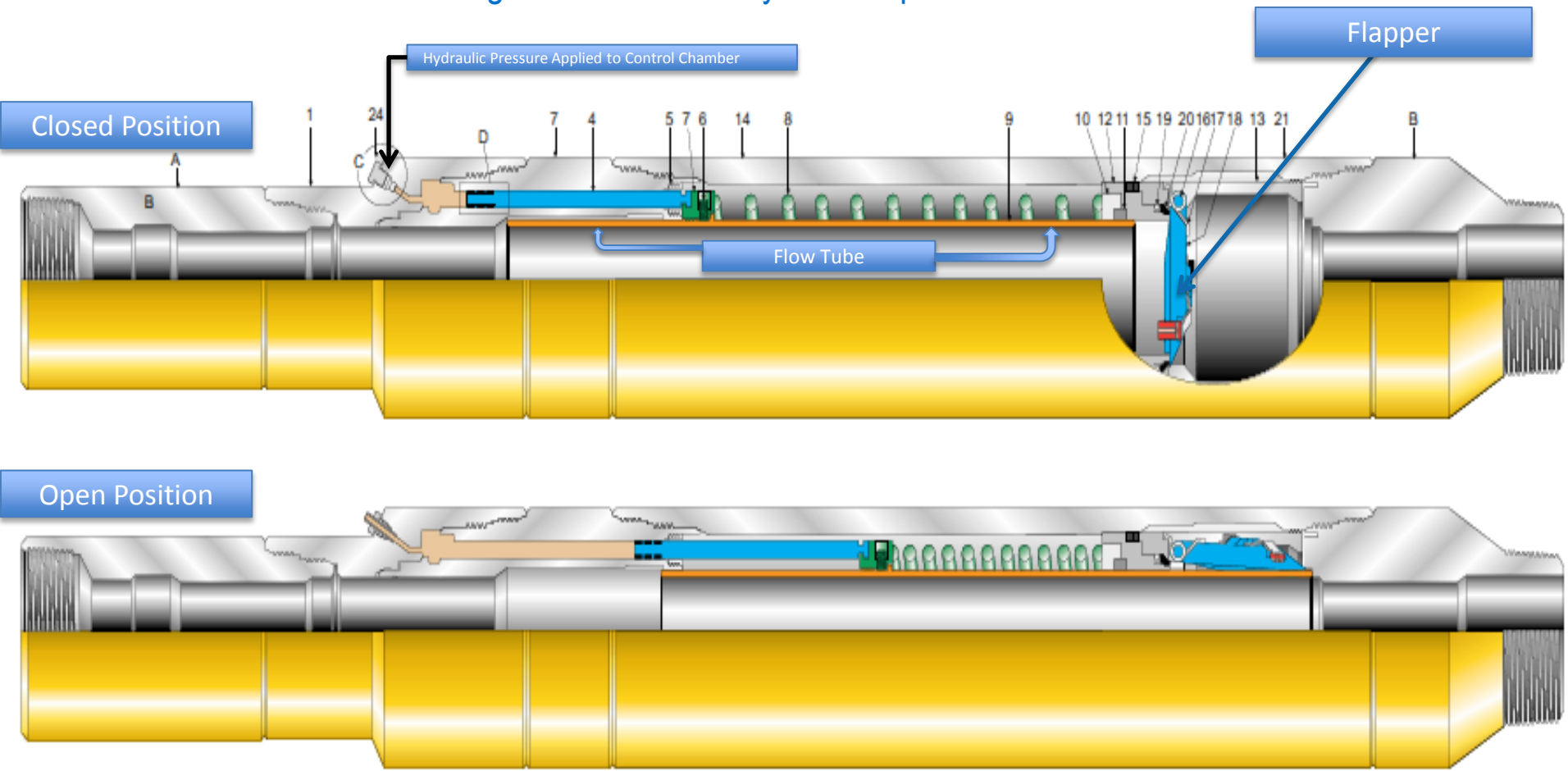
- Advantages
  - **Most reliable**
  - Most Extensively Used
  - Non-elastomeric design (For Gas Environments)
  - If it fails, it has capability of being locked open to accept a wireline valve
  - Approx Same ID as Tubing
    - Minimum pressure drop thru Valve
    - Minimal turbulence
    - Does not restrict wireline operations

- Disadvantages
  - In some casing sizes, valve will restrict the size of tubing that can be used
  - Tubing string must be pulled to retrieve/replace valve
  - More Expensive than Wireline Retrievable Safety Valves (WRSVs)



BAKER HUGHES

Tubing Retrievable Safety Valve Open/Closed Position

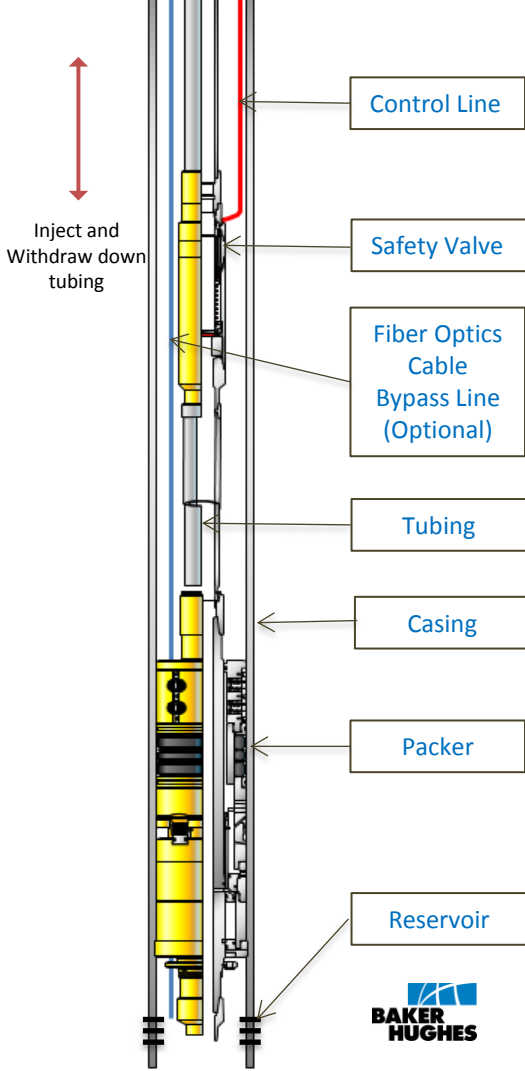


Safety Valve Installation

ADVANTAGES of Using Tubing/Safety Valve Installation:

- ✓ Provides Protection during Wellhead Integrity Loss
  - ▪ Protects Investment & People
- ✓ Protects Casing – Eliminates/Reduces Wear
  - • Extends Well Life
  - • Reduces Workover Costs
  - • Reduces / Eliminate Wellbore Maintenance

Given Casing Size (Most common Weights)	Largest (Nominal Size) Safety Valve That Will Fit Inside Casing Drift ID (5000 psi Working Pressure valve)
4-1/2”	2-3/8”
5-1/2”	2-7/8”
6” or 6-5/8”	3-1/2”
7”	4-1/2”
8-5/8”	5-1/2”
9-5/8”	7”
13-3/8”	9-5/8”



Wireline Conveyed Surface Controlled Subsurface Safety Valves

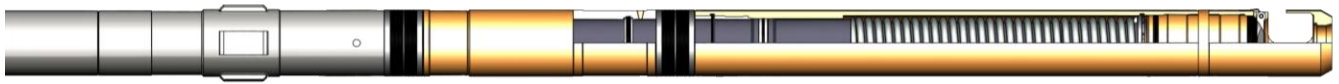
[1] Fit *inside* Tubing Conveyed Safety Valve Landing Nipples or
[2] Failed Tubing Conveyed SV

Advantages

- Good Serviceability – Run on Slickline inside Tubing
- Sometimes enable the use of larger tubing size
- Valve can be pulled & repaired independently from pulling tubing string
- Back-up option for TRSVs
- **LESS EXPENSIVE**

Disadvantages

- More components – Lock & Packing
- Seal Bore Vulnerability
- Restricts wireline operations
- Elastomeric Designs
- **SMALL ID**
  - Restricts Flow
  - Creates a pressure drop
  - Potential for Tubing Erosion/Corrosion

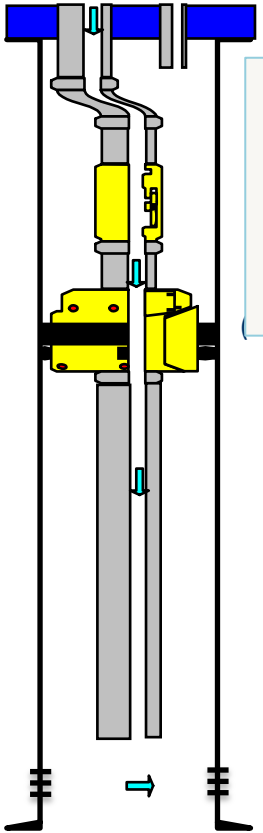


Wireline Retrievable Safety Valve

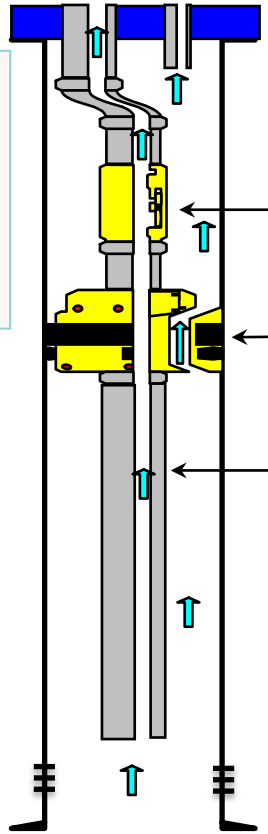
Annular Safety Systems

- ✓ Ability to withdraw up Tubing and Annulus Simultaneously
- ✓ Maximized Production for Given Casing Size using Safety Valve Protection
- ✓ Serves as a redundant Wellhead

- Safety Valve Protection – Tubing and Annular Protection
- Independent Assemblies
- Surface Controlled Devices
- Annular Safety Valve/Tbg Hanger
- Limited Sizes Currently Available

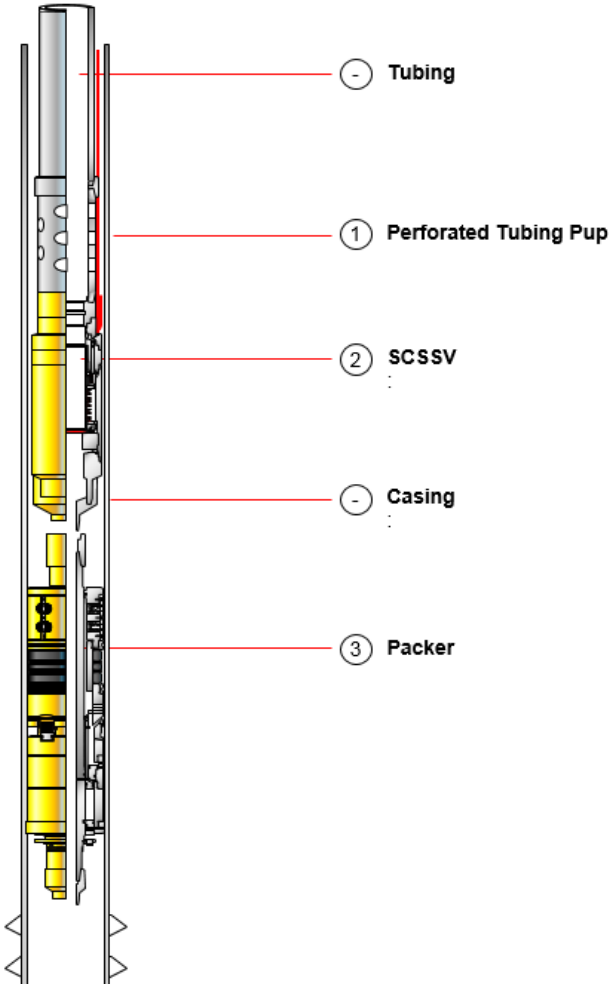


INJECTION



WITHDRAW

Single Tubing Control Safety Valve – Tubing & Annulus Flow



Annulus & Tubing Flow

- ✓ Greater Withdraw Rate
- ✓ Safety Valve
- ✓ Can be run with Deflector Plate if needed to protect casing from erosion
- ✓ Assembly can be set high or low in well

BAKER HUGHES

Take-Aways for Safety Valves

- Maintenance Programs Can Prolong SV Life - Features Include:
  - Flapper Integrity Testing @ regular intervals
  - Periodic Cycling to keep seals lubricated
  - Additional Procedures dictated by well environment
- Tubing- Safety Valve - Packer Arrangement:
  - Most Common Arrangement
  - Packer & SV can be set high or low In Wellbore to accommodate Wellbore/Operator Needs
- Valve Designs
  - Slam Testing done on all Safety Valves to ensure closing Mechanism can withstand hi-rate Flapper-to-Seat Impact in a Slam-Closure event (Velocities calculated in feet per second)
  - Most Important Optional SV Feature: **Self-Equalizing**
  - SV's available in (Tubing) size ranges from **2-3/8" to 9-5/8"**. Deep Set Valves available to 20K feet
  - Flapper Integrity Design:
    - Maximum Differential Pressure across a closed flapper = Working Pressure (Testing Range from WP to 200 psi Δ)
    - Leak Rate of Closed Flapper sufficiently low enough to enable operator to safely reconnect to Tubing
    - API RP 14B – Document to Determine Acceptable Performance Limits for In-Service Valves
- Safety Valve Reliability / Test Program is KEY to Success (Oil Industry & GSO)
- Recommended Minimum Qualification Standards from SV Suppliers

Safety Valve Design & Mfg.	Product Certifications	Quality Management Systems
API 14A	API 14A API 14L	ISO 9001/2008 API Q1

BAKER HUGHES